

Bosch Manufacturing Solutions | BMG

Sales presentation as of 04.2025

BOSCH

BMG | **who we are**

Bosch Manufacturing Solutions | BMG –

Global industrialization partner & turnkey special machinery provider for production equipment & automation

- > 30 years of experience as special machinery supplier
- > 4.000 assembly & testing systems
  > 10.000 small & services projects
- Automation level adjustable, semi- to fully automated solutions
- Digital planning & process to digital engineering & i4.0 applications



>17
Locations

Full-liner
portfolio

Several industries & product areas

1.900
Employees

~680
TNS m€

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BMG | **our purpose statement**
The difference in manufacturing



For us, **‘Invented for life’** means to build a **more sustainable future** through production equipment by Bosch Manufacturing Solutions.

We create a difference in our customers’ products by offering **“the difference in manufacturing”**

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BOSCH

BMG | **our portfolio**
Customized assembly & testing systems



Global industrialization partner & turnkey special machinery provider for production equipment & automation, offering

Customized assembly & testing systems

empowered by ...



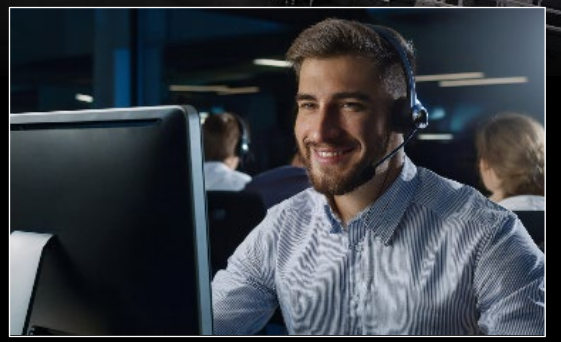
Engineering Consulting & Digital Engineering



Advanced Manufacturing Processes & Technologies



Digital & Intelligent Solutions

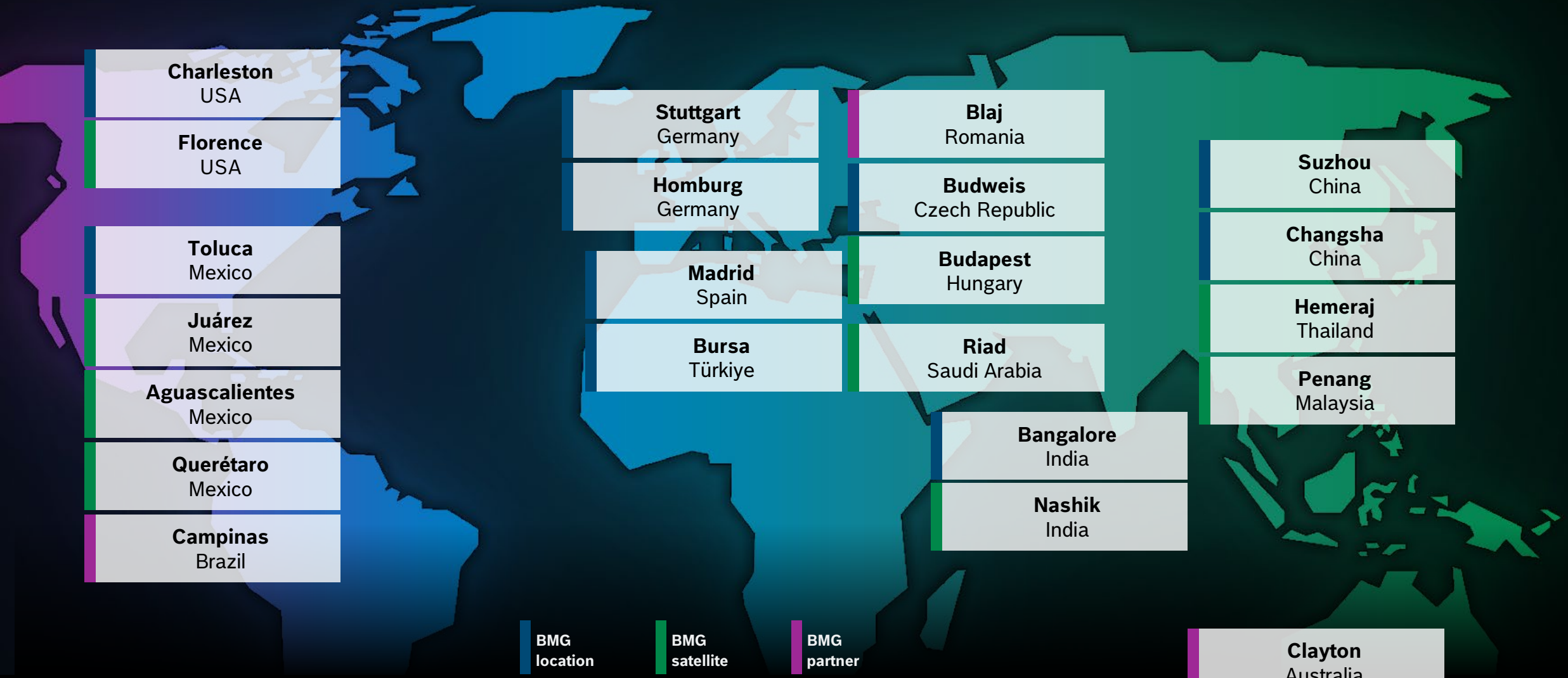


Services along the entire product lifecycle

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BMG | **global strength in network & partners**



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BOSCH

BMG | **focus industries & product areas**

Focus industries


eMobility


Automotive (ICE)


Energy

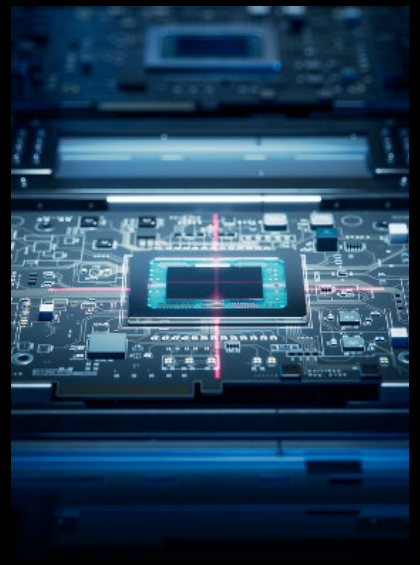

Consumer Goods

Focus product areas

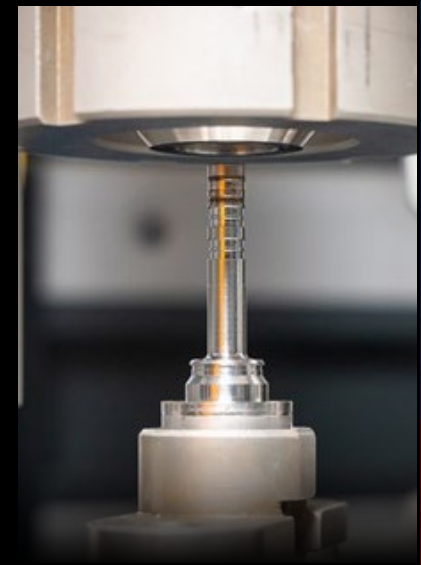

Battery


H2 Solutions / Fuel Cell


eDrive


Sensors & Electronics


Chassis & Steering


Combustion Engine

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BOSCH

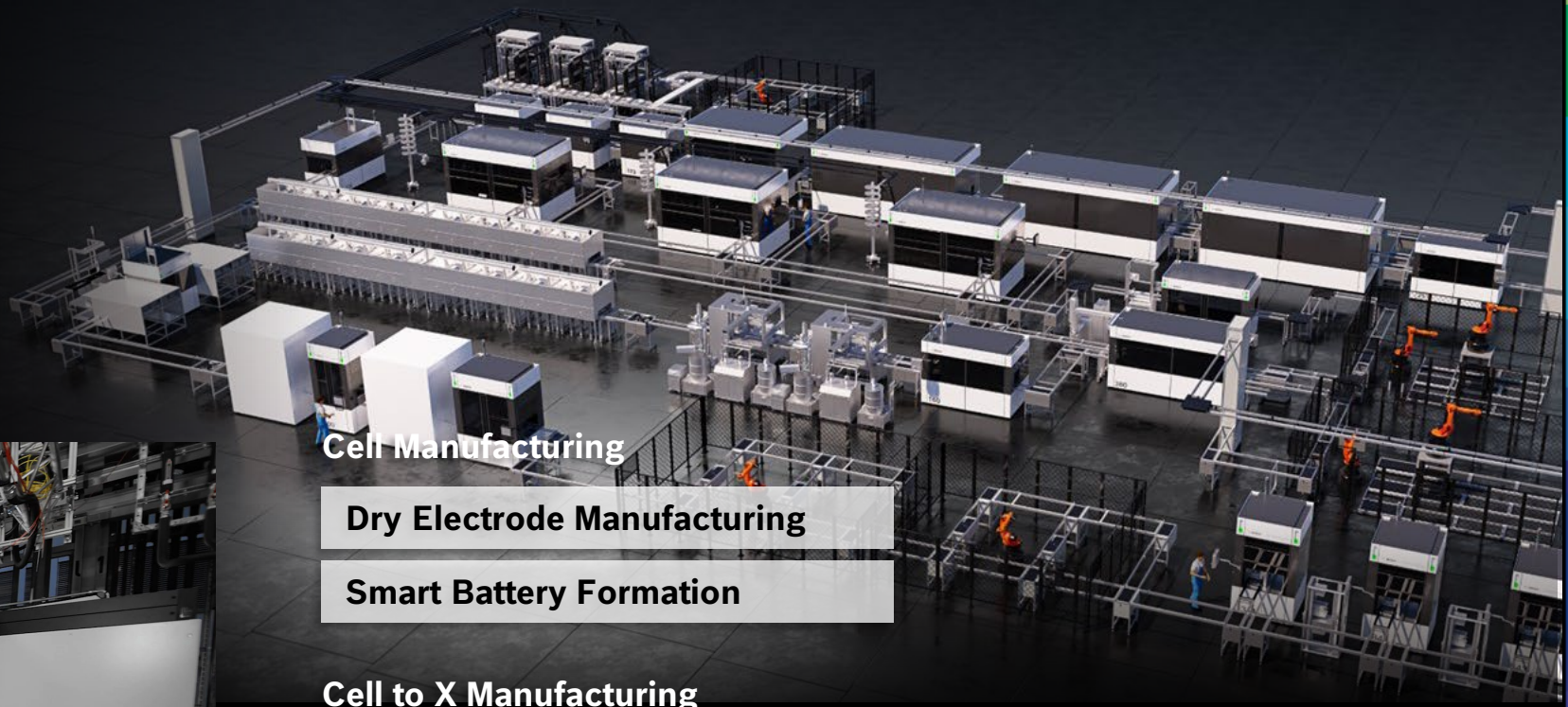
BMG | **focus industries & product areas**

Battery

Stay charged

with battery production equipment from Bosch Manufacturing Solutions | BMG. Our expertise reaches from cell production technologies up to fully automated and intelligent Cell to X assembly and testing systems.





Cell Manufacturing

- Dry Electrode Manufacturing
- Smart Battery Formation

Cell to X Manufacturing

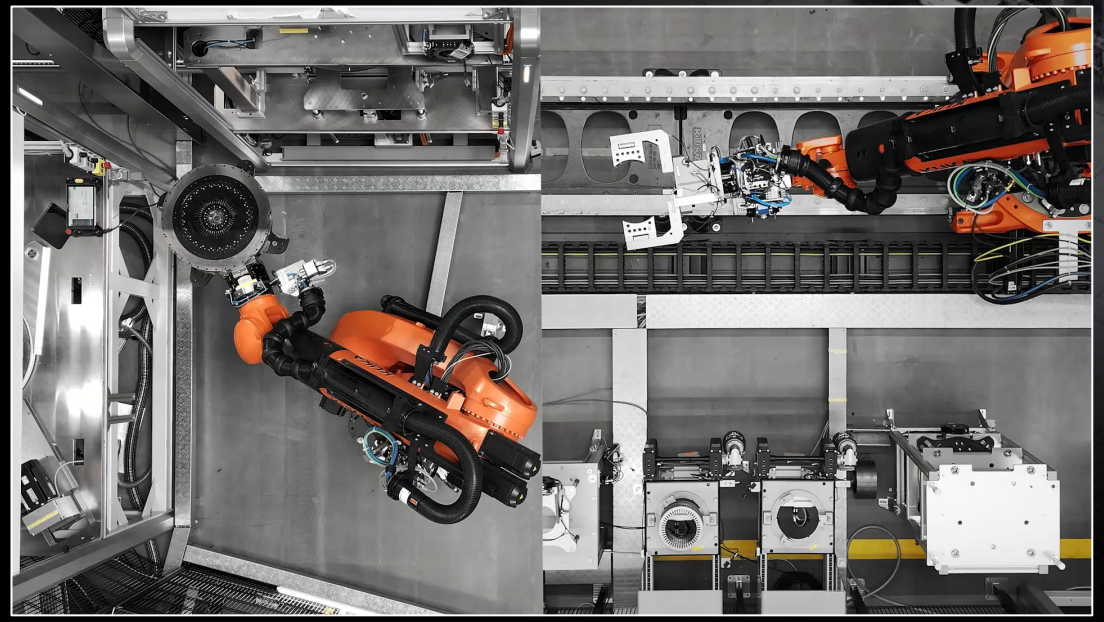
- Cell Supply
- Cell Cleaning
- Begin & End of Line Testing
- Dispensing
- Resistance Welding
- Laser Welding
- Machine Vision
- Leakage Testing

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Driving mobility

with innovative eDrive production equipment from Bosch Manufacturing Solutions | BMG. Our expertise ranges from various winding technologies such as Hair-Pin, I-Pin, X-Pin, for all vehicle classes, to individual line concepts from semi to fully automated, including AI based solutions for increased efficiency.



eDrive Lab

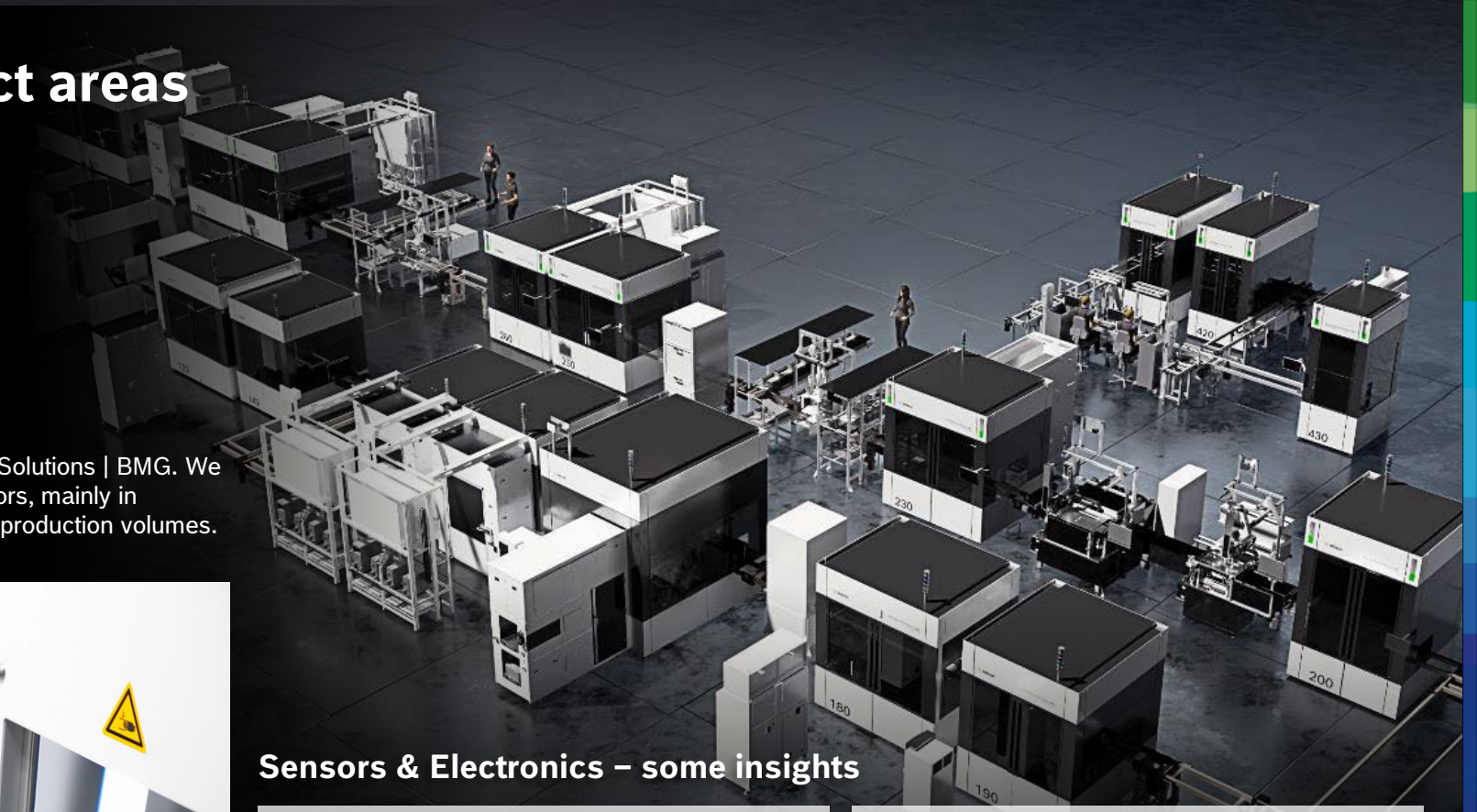
eDrive – some process highlights

Pin Manufacturing	**Trickling**
Handling & Robotics	**Clamping**
Twisting	**Optical Inspection: Post Vision**
Laser Welding	**Parameter Identification (PI) Testing**
Separating & Cutting	**Further ...**

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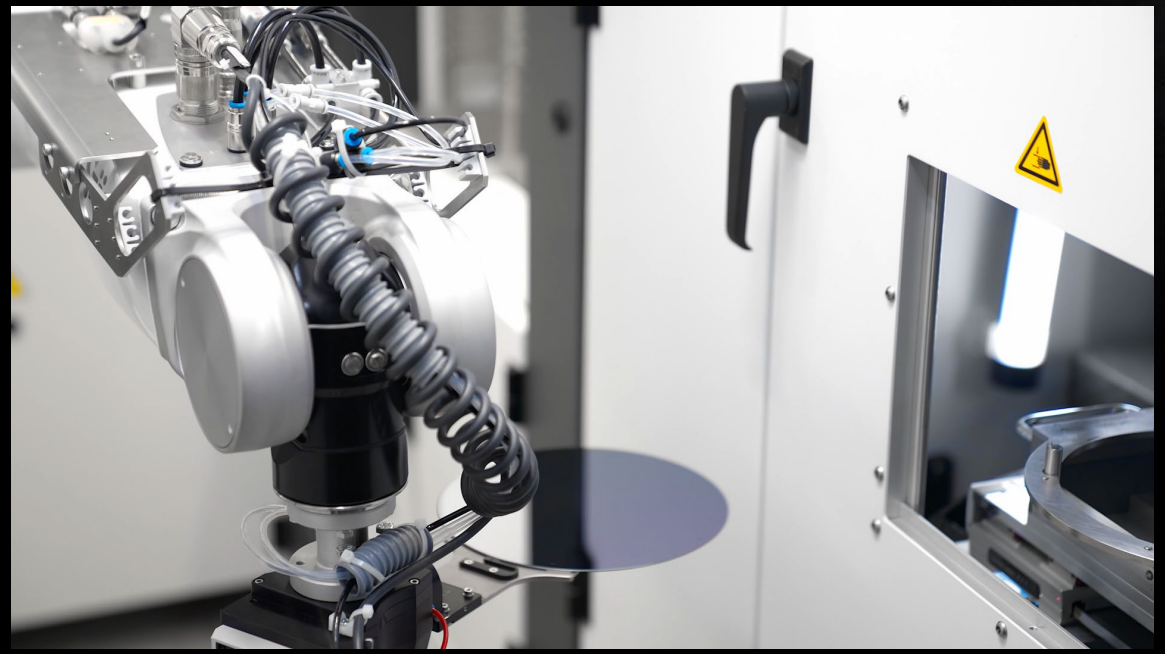
BOSCH

BMG | **focus industries & product areas**
Sensors & Electronics



Unleash power

with sensors & electronics production equipment from Bosch Manufacturing Solutions | BMG. We provide flexible assembly technology for ECUs, power electronics, and sensors, mainly in eMobility. Our scalable solutions optimize investments and adapt to variable production volumes.



Sensors & Electronics – some insights

Flexfoil Handling	Screwing
Laser Welding of Electrical Connections	Pressfit & Single Pin Insertion
Laser Micro Structuring	Optical Inspection
Laser Cleaning	Magnetic Conveyor System
Dispensing	

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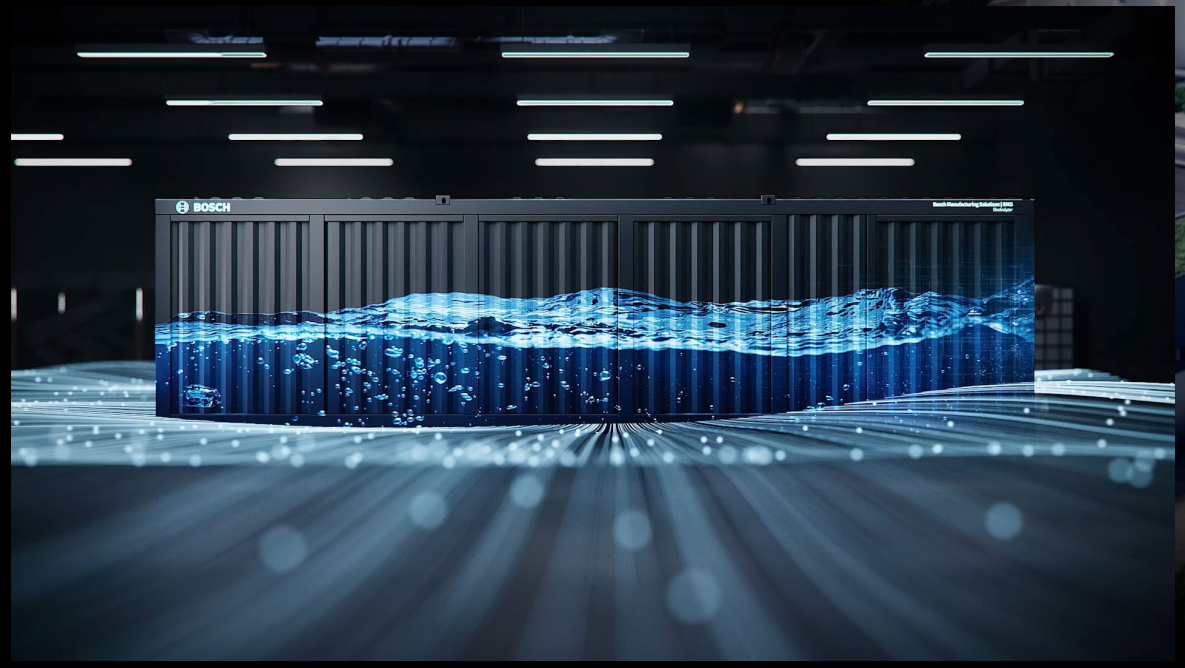
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H2 Solutions

» Reference Project NorthH2 & Fraunhofer IWES

From Water to Energy –

empower your sustainable future with H_2 solutions by Bosch Manufacturing Solutions | BMG, in the area of water purification & electrolysis, fuel cell assembly & testing as well as power generation.



» H2 circle – BMG as system industrialization partner

Water Purification

- » BMG Pure Water System

Electrolysis – from water to hydrogen

- » PEM Ely Stack Testing
- » PEM Electrolyzer System
- » AEM Ely Stack Testing
- » SOEC Stack Testing

Fuel Cell – from hydrogen to energy

- » PEMFC Testing
- » PEMFC – FCPM Assembly & Testing
- » PEMFC – FCPM Power Generator
- » PEMFC – FCPM – Bipolar Plates Processes
- » PEMFC – Coatings

- » Hydrogen Gas Injection

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BMG | **focus industries & product areas**
Chassis & Steering



As a technology and process expert for the automotive industry, we offer you the optimum manufacturing equipment for various components in the field of chassis and steering.

From hydraulic to electric steering and driving systems: New Braking Systems like the Integrated Power Brake (IPB) and the electronic stability program (ESP) are just some examples of components manufactured with equipment from Bosch Manufacturing Solutions | BMG.

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BMG | **focus industries & product areas**
Combustion Engine



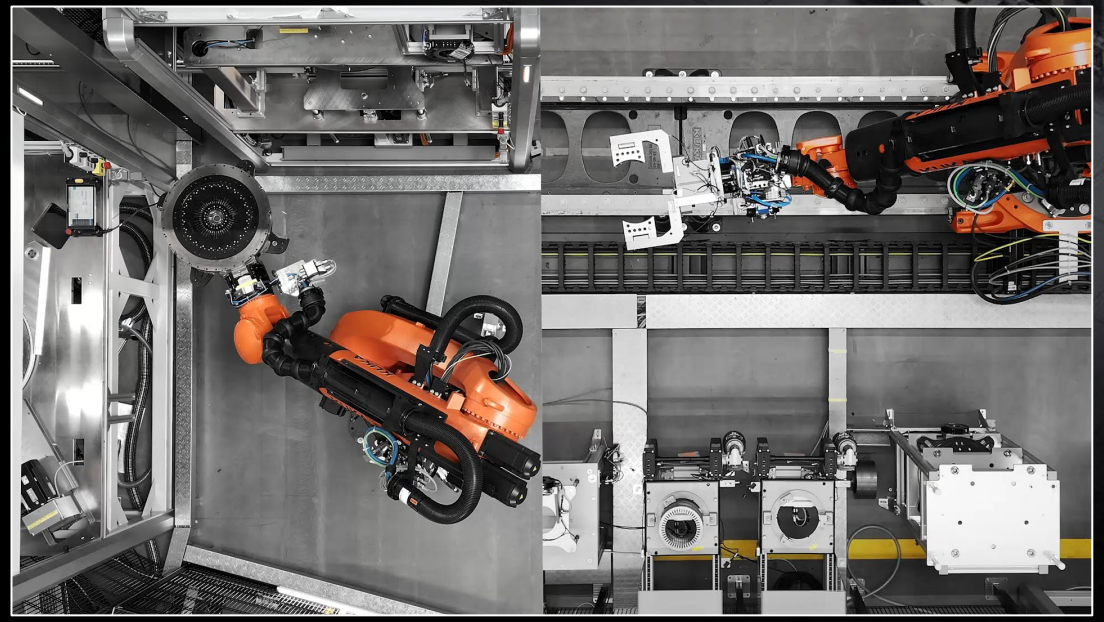
Our high-precision production and testing equipment for diesel and gasoline injection systems, e.g. including high-pressure injectors, diesel pumps, and exhaust gas systems, are backed by the expertise of Bosch Manufacturing Solutions | BMG.

As the ICE sector matures, our services are crucial in maximizing performance and extending the lifetime of your systems. From cycle time improvements and modernizations to relocation projects, we ensure peak efficiency throughout your equipment's lifecycle.

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Driving mobility

with innovative eDrive production equipment from Bosch Manufacturing Solutions | BMG. Our expertise ranges from various winding technologies such as Hair-Pin, I-Pin, X-Pin, for all vehicle classes, to individual line concepts from semi to fully automated, including AI based solutions for increased efficiency.



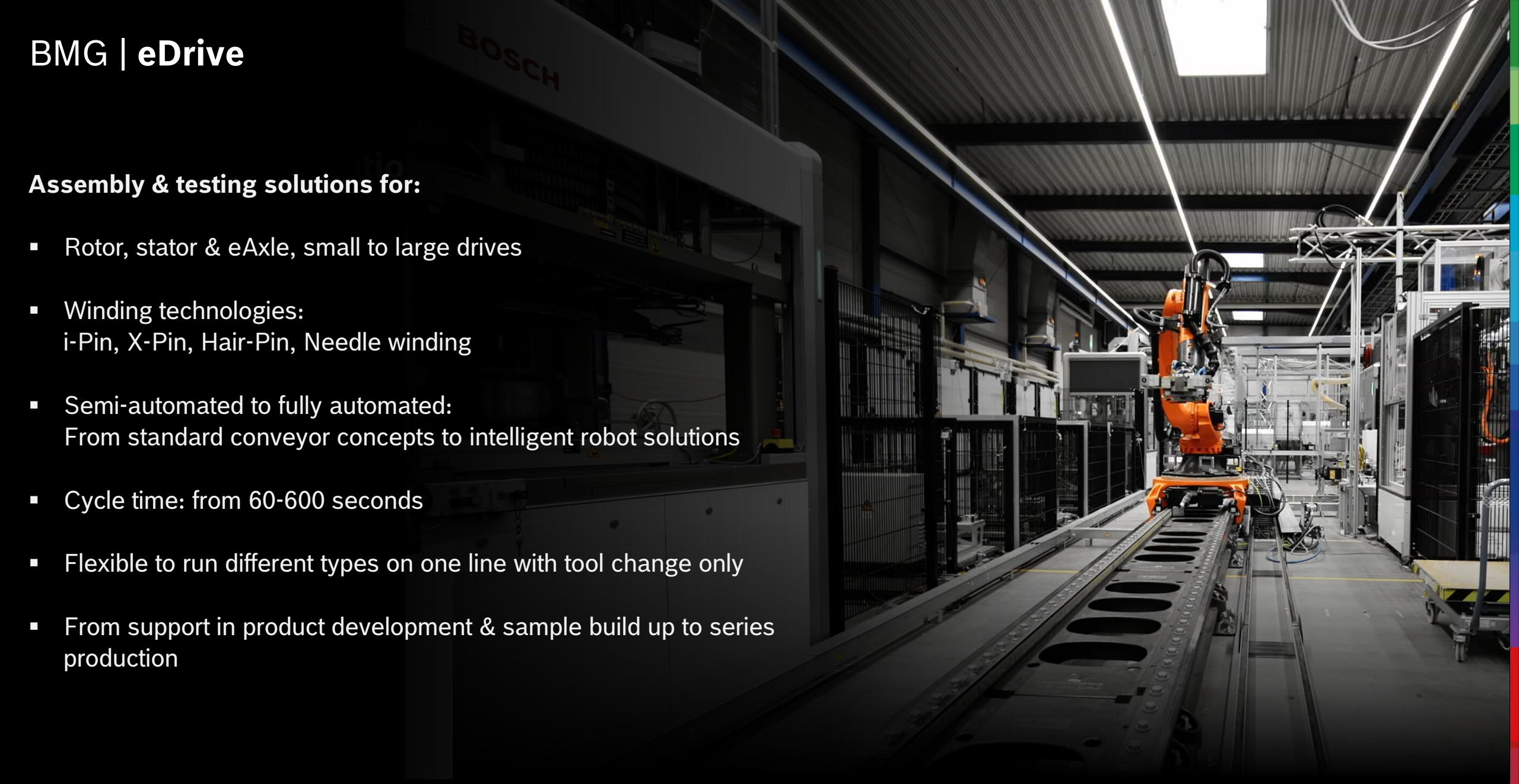
eDrive Lab

eDrive – some process highlights

Pin Manufacturing	**Trickling**
Handling & Robotics	**Clamping**
Twisting	**Optical Inspection: Post Vision**
Laser Welding	**Parameter Identification (PI) Testing**
Separating & Cutting	**Further ...**

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BMG | **eDrive**

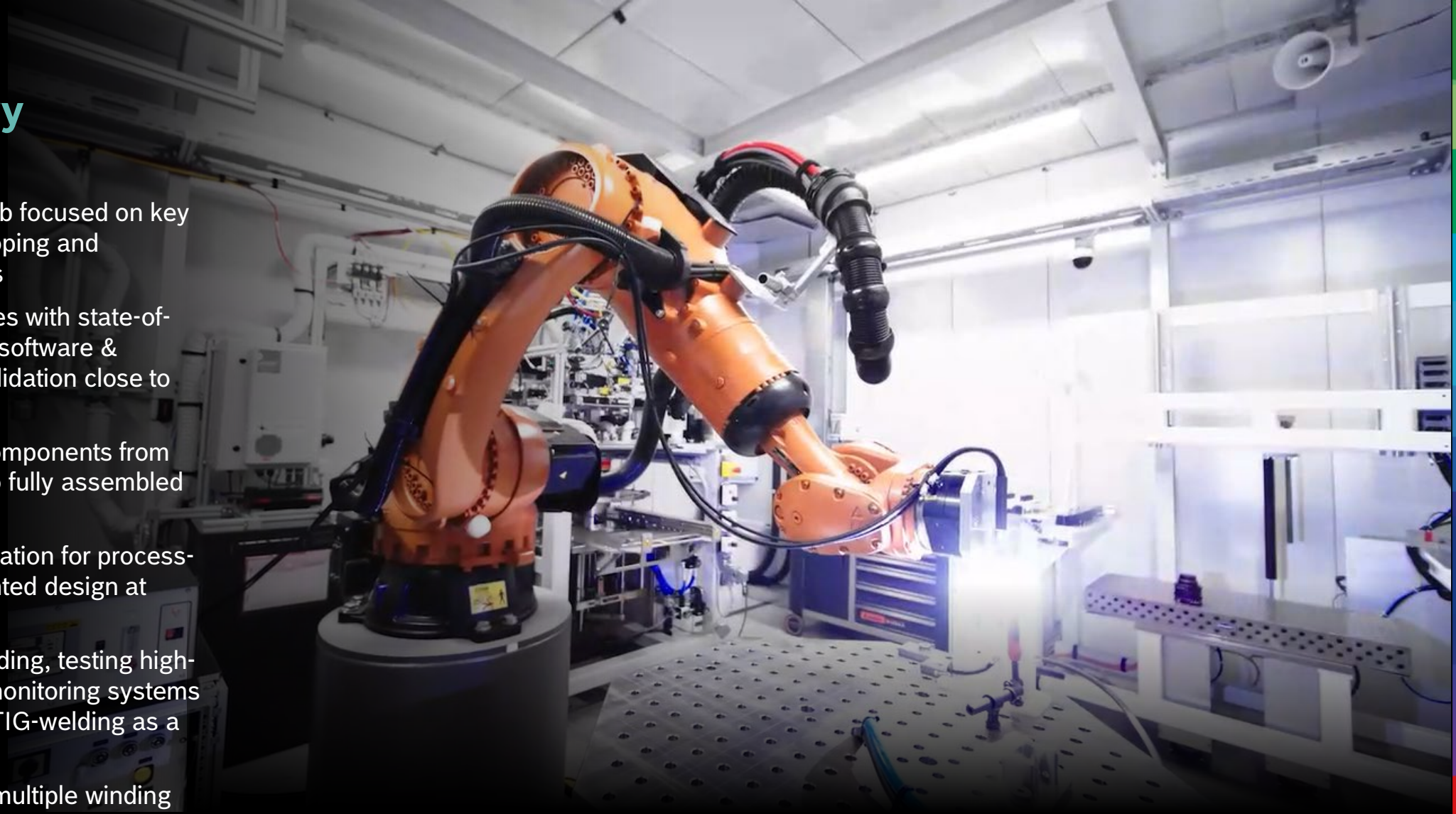


Assembly & testing solutions for:

- Rotor, stator & eAxle, small to large drives
- Winding technologies:
  i-Pin, X-Pin, Hair-Pin, Needle winding
- Semi-automated to fully automated:
  From standard conveyor concepts to intelligent robot solutions
- Cycle time: from 60-600 seconds
- Flexible to run different types on one line with tool change only
- From support in product development & sample build up to series production

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BMG | eDrive
eDrive laboratory



- Fully equipped eDrive lab focused on key process steps for developing and optimizing electric drives
- Advanced testing facilities with state-of-the-art control systems, software & hardware for realistic validation close to series production
- Capable of producing components from experimental samples to fully assembled stators
- Close customer collaboration for process- and manufacturing-oriented design at every sample phase
- Specializing in laser welding, testing high-power lasers, optics & monitoring systems – while also evaluating TIG-welding as a cost-effective alternative
- Flexible twisting lab for multiple winding types (I-Pin, Hairpin, X-Pin) with up to 8 twisting layers, 100 kN axial load and 4.5 kNm torque per layer

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BMG | eDrive | references
Stator manufacturing mid volume line

- Special feature: **robot on 7th axle rail**, one-process-machines
- Shortest time frame from request to ready for production
- Standard stations on Hair-Pin technology lines
- **Tools can be exchanged between different lines** with short change over time
- Less construction effort
- Cost reduction through scalability & flexibility
- **Easier by introducing new stator types within the range**
- Joint process developing with customer



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BMG | eDrive | references

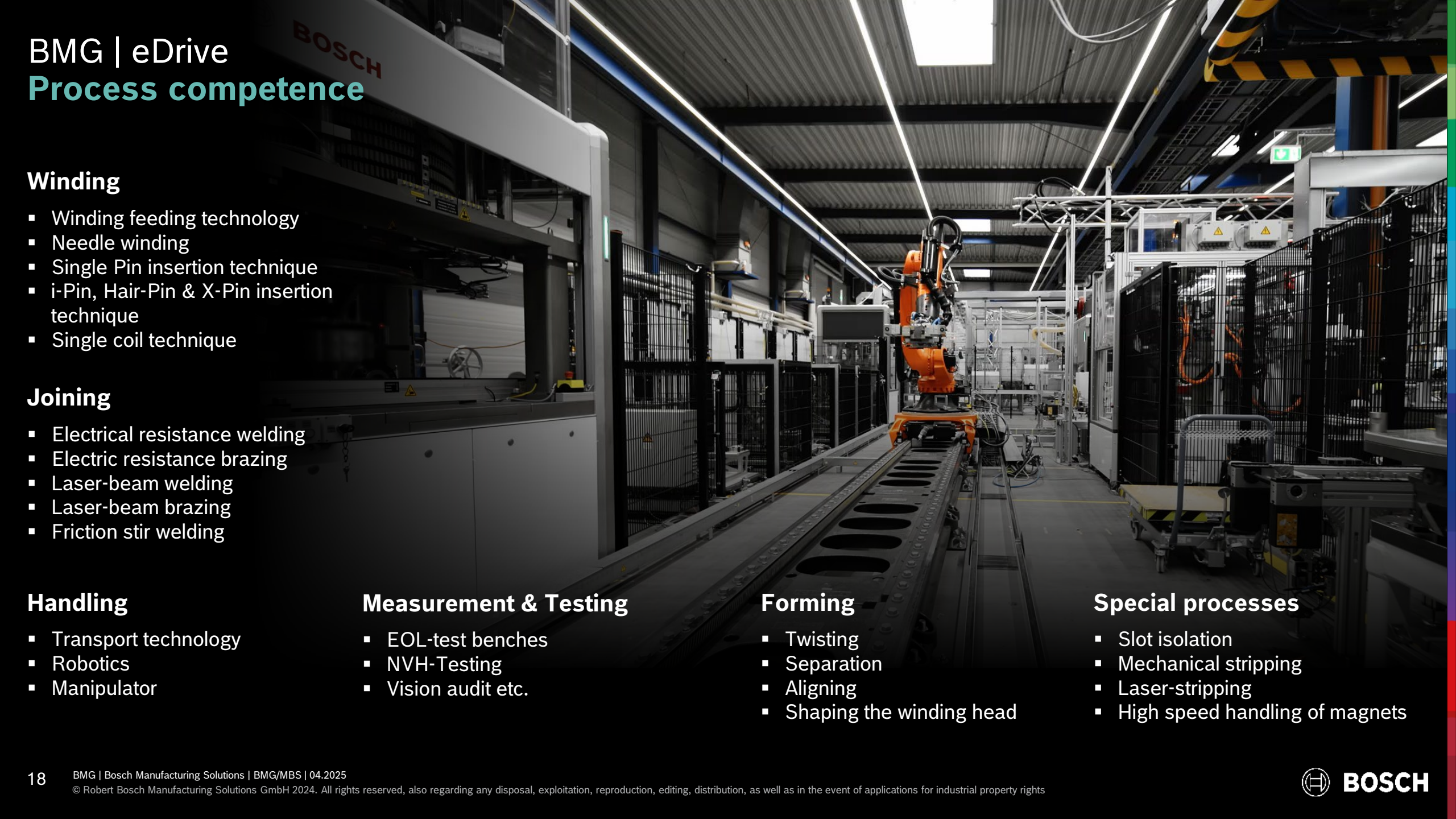
Reference: Stator manufacturing high volume line



- Optimization and further development from previous iPin
  → **new line concept with robot cells & clamping mask**
- From standard “transfer belts concept” to **flexible robot cell**
- “Masterline” for all Hairpin lines
  → Focus on **standardization** as main advantage for our customers
- **Scalability & flexibility** due to:
  - robot centred line design
  - flexible, exchangeable decoupled process stations
  - scalability due to increase of process stations and therefore cycle time reduction (60s > 600s)
- Joint process developing with customer

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BMG | eDrive
Process competence



Winding

- Winding feeding technology
- Needle winding
- Single Pin insertion technique
- i-Pin, Hair-Pin & X-Pin insertion technique
- Single coil technique

Joining

- Electrical resistance welding
- Electric resistance brazing
- Laser-beam welding
- Laser-beam brazing
- Friction stir welding

Handling

- Transport technology
- Robotics
- Manipulator

Measurement & Testing

- EOL-test benches
- NVH-Testing
- Vision audit etc.

Forming

- Twisting
- Separation
- Aligning
- Shaping the winding head

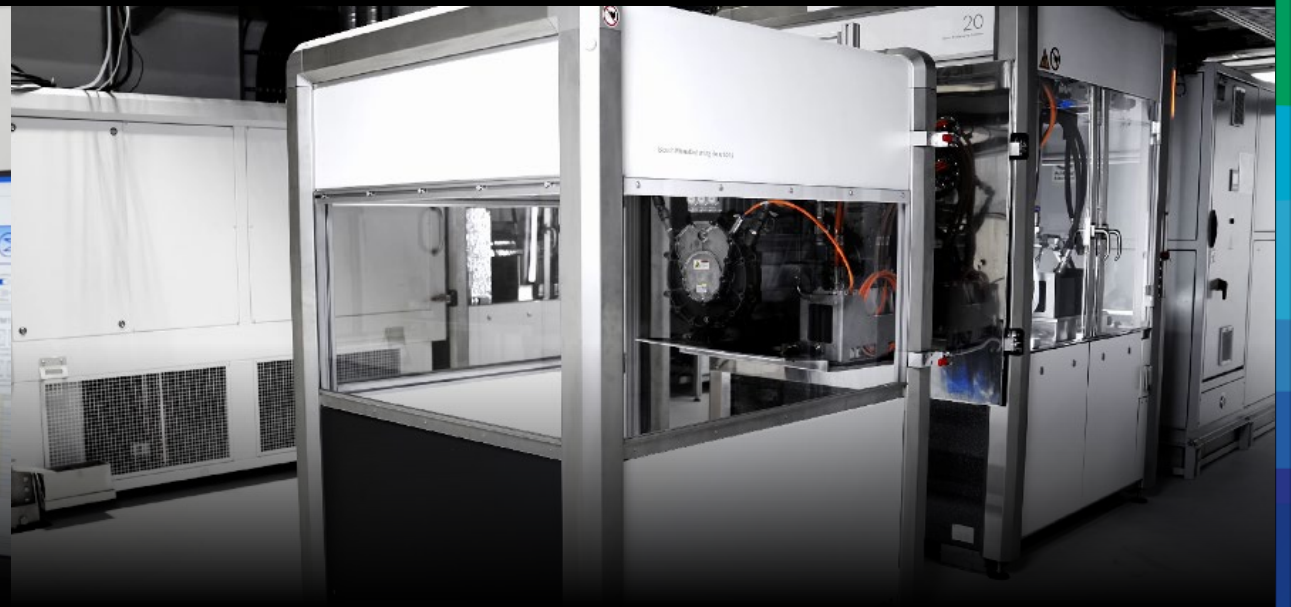
Special processes

- Slot isolation
- Mechanical stripping
- Laser-stripping
- High speed handling of magnets

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BMG | eDrive
Testing solutions

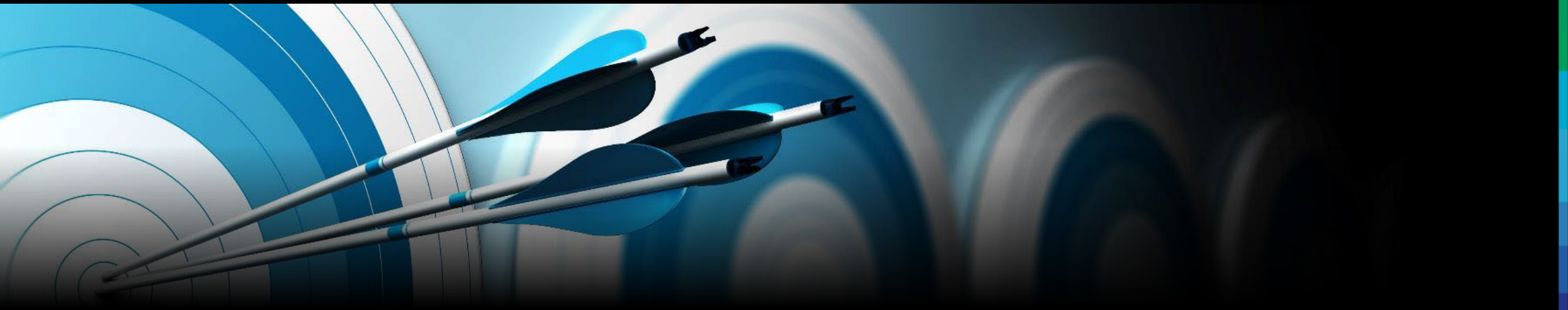




- Flexible test bench for **small to extra large** (off-highway) eDrives
- Testing options are tailored for powerful applications, accommodating DUTs with a frequency converter **performance of up to 500 kW**
- **Dynamic testing flexibility**: combinations of {high torque, low speed} & {high speed, low torque} can be operated in both generator and motor modes, increasing the testing performance
  - High-speed up to 20.000 rpm or
  - High torque up to 3 KNm
- Testing with load as standard or advanced and cost attractive testing without load (parameter identification)
- Support **from lab to series production**

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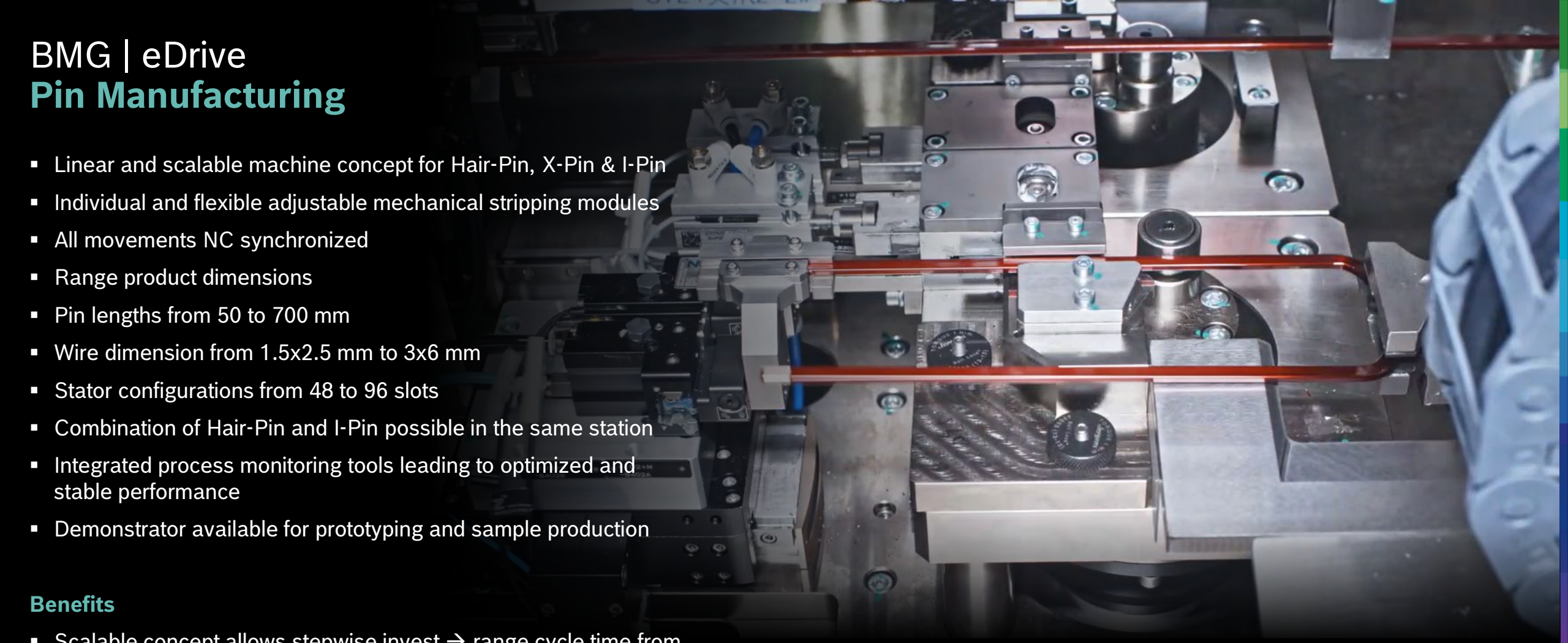
BMG | eDrive
Success story



- Know-how in assembly & testing of rotor, stator & e-machine
- Process improvement with artificial intelligence (AI)
- Flexible to run different types on one line with tool change only
- More than 25 lines in production
- Biggest single project volume: 50 Mio. €
- Technology center in Feuerbach to support product development & sample build
- Advanced laser welding technology
- Scalable solutions from 60-600 sec
- Bosch Plant Hildesheim awarded as best production plant e-machine in D/A/CH 2023 → Supplier for stator production is BMG

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BMG | eDrive
Pin Manufacturing



- Linear and scalable machine concept for Hair-Pin, X-Pin & I-Pin
- Individual and flexible adjustable mechanical stripping modules
- All movements NC synchronized
- Range product dimensions
- Pin lengths from 50 to 700 mm
- Wire dimension from 1.5x2.5 mm to 3x6 mm
- Stator configurations from 48 to 96 slots
- Combination of Hair-Pin and I-Pin possible in the same station
- Integrated process monitoring tools leading to optimized and stable performance
- Demonstrator available for prototyping and sample production

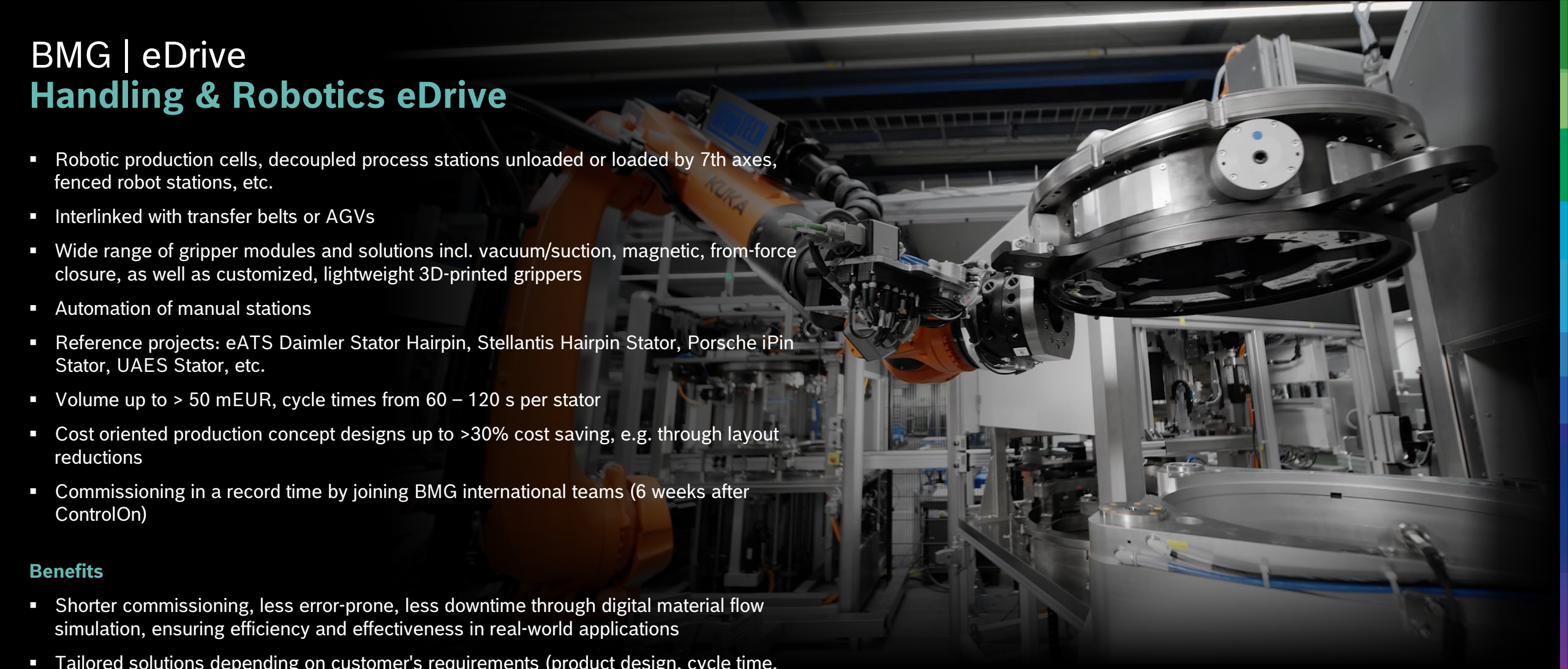
Benefits

- Scalable concept allows stepwise invest → range cycle time from 60 to 600s
- Adaptability to different pin shapes, incl. special shapes like X-Pin

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BMG | eDrive
Handling & Robotics eDrive



- Robotic production cells, decoupled process stations unloaded or loaded by 7th axes, fenced robot stations, etc.
- Interlinked with transfer belts or AGVs
- Wide range of gripper modules and solutions incl. vacuum/suction, magnetic, from-force closure, as well as customized, lightweight 3D-printed grippers
- Automation of manual stations
- Reference projects: eATS Daimler Stator Hairpin, Stellantis Hairpin Stator, Porsche iPin Stator, UAES Stator, etc.
- Volume up to > 50 mEUR, cycle times from 60 – 120 s per stator
- Cost oriented production concept designs up to >30% cost saving, e.g. through layout reductions
- Commissioning in a record time by joining BMG international teams (6 weeks after ControlOn)

Benefits

- Shorter commissioning, less error-prone, less downtime through digital material flow simulation, ensuring efficiency and effectiveness in real-world applications
- Tailored solutions depending on customer's requirements (product design, cycle time, handling processes, space, changeover..)
- High flexibility regarding integration of known robot and cobot brands such as Cartesian, SCARA, Delta, 6/7-axis robot arms & combination with linear axes, ...
- Reduced time to market and costs through digital validation and virtual commissioning

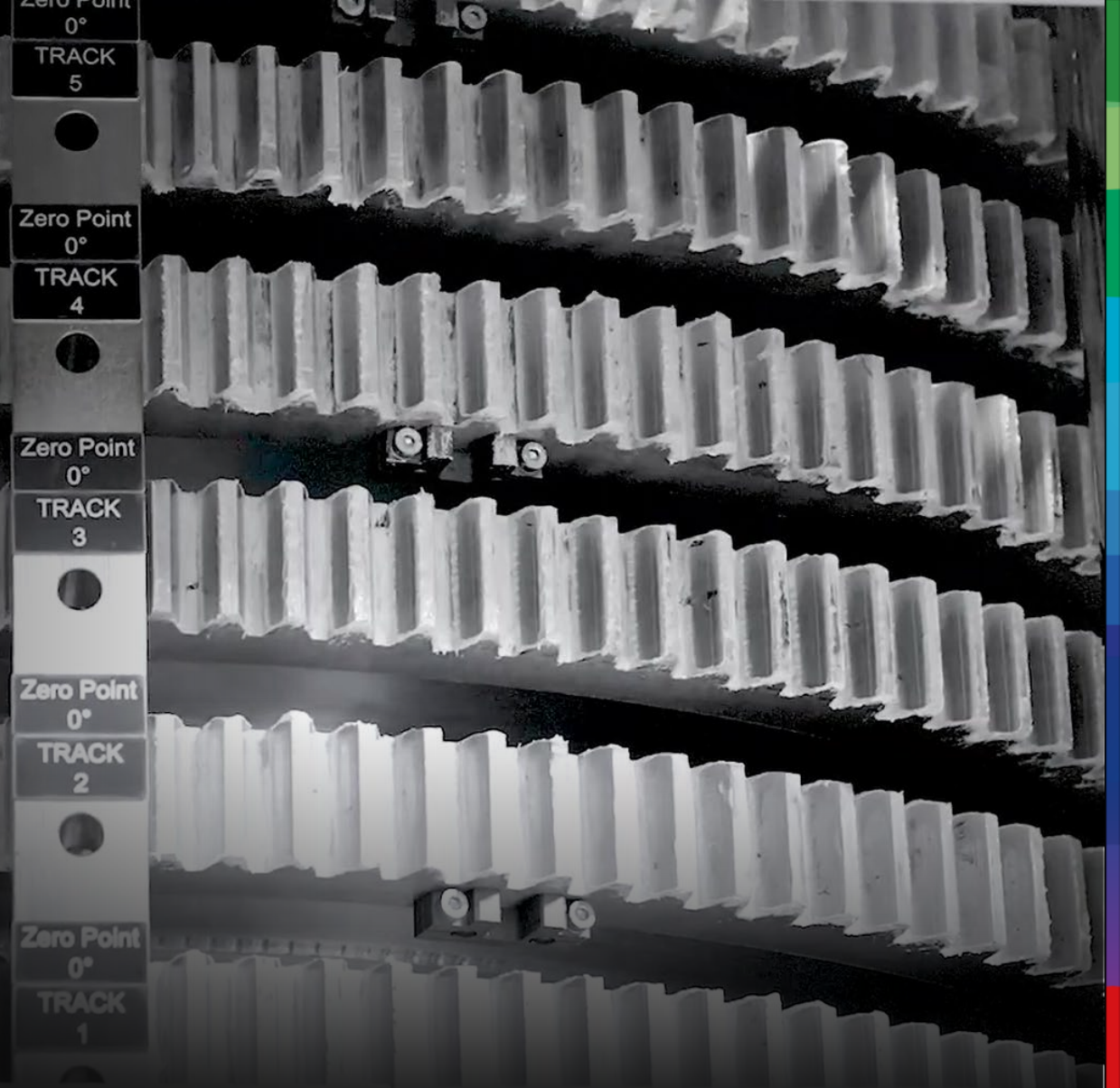
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BMG | eDrive
Forming – Twisting for eDrive

- Twisting for wire connection for normal & special wires, and for I-/U-/IX-/UX-Pin
- Automatical tool re-equip (via robots or transfer)
- Fully synchronized movements allow for a robust process
- Compact machine in vertical setup
- Synchronized twisting of up to 10 layers
- Axial force up to 100 kN
- Torque up to 4.500 Nm

Benefits

- Less wear on the tool due to prevention of soiling by setting with wire ends upwards
- User-friendly, fast and robust parameter adjustments possible also by non-programmers
- Standardized machine / tooling interface for high tooling compatibility
- High flexibility in twisting of different products due to 360° track turning



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BMG | eDrive
Laser welding of stator for eDrive

- Customizable, user-friendly, flexible and reliable laser welding for wire ends and busbars
- High-power lasers up to 10 kW, higher outputs possible
- Single-mode fiber lasers up to 4 kW
- Positioning accuracy of the weld +/- 100 µm
- Active laser protection
- Cycle time (depending on product) approx. 60sec with ~140 welding points

Benefits

- Customized integration of optimum laser system technology from various manufacturers (various stator types available: I-Pin, Hairpin, X-Pin)
- Customized welding process control through own scanner control leads to an increase in first runs and less NOK parts < 5%
- User-friendly operation through menu-guided set-up and calibration processes
- In-house scanner control offers maximum flexibility in terms of welding strategies and integration of measurement technology
- Process reliability thanks to clamping concepts with the option of equalizing tolerances from previous processes
- Integration of a wide range of measurement technology (OCT, EBC, protective glass monitoring, drift compensation, welding position determination in 2D & 3D)



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BMG | eDrive
Separating for eDrive



- Highly modern machines for fast and reliable separating processes of connecting, special and joint wires in 60s including handling
- In development: Easy and cost-efficient station set-up for ring separating with reduced complexity and user-friendly parameter adjustment
- Horizontal annular construction
- Arrangement of 1 - 6 separation heads
- Unitary separation head

Benefits

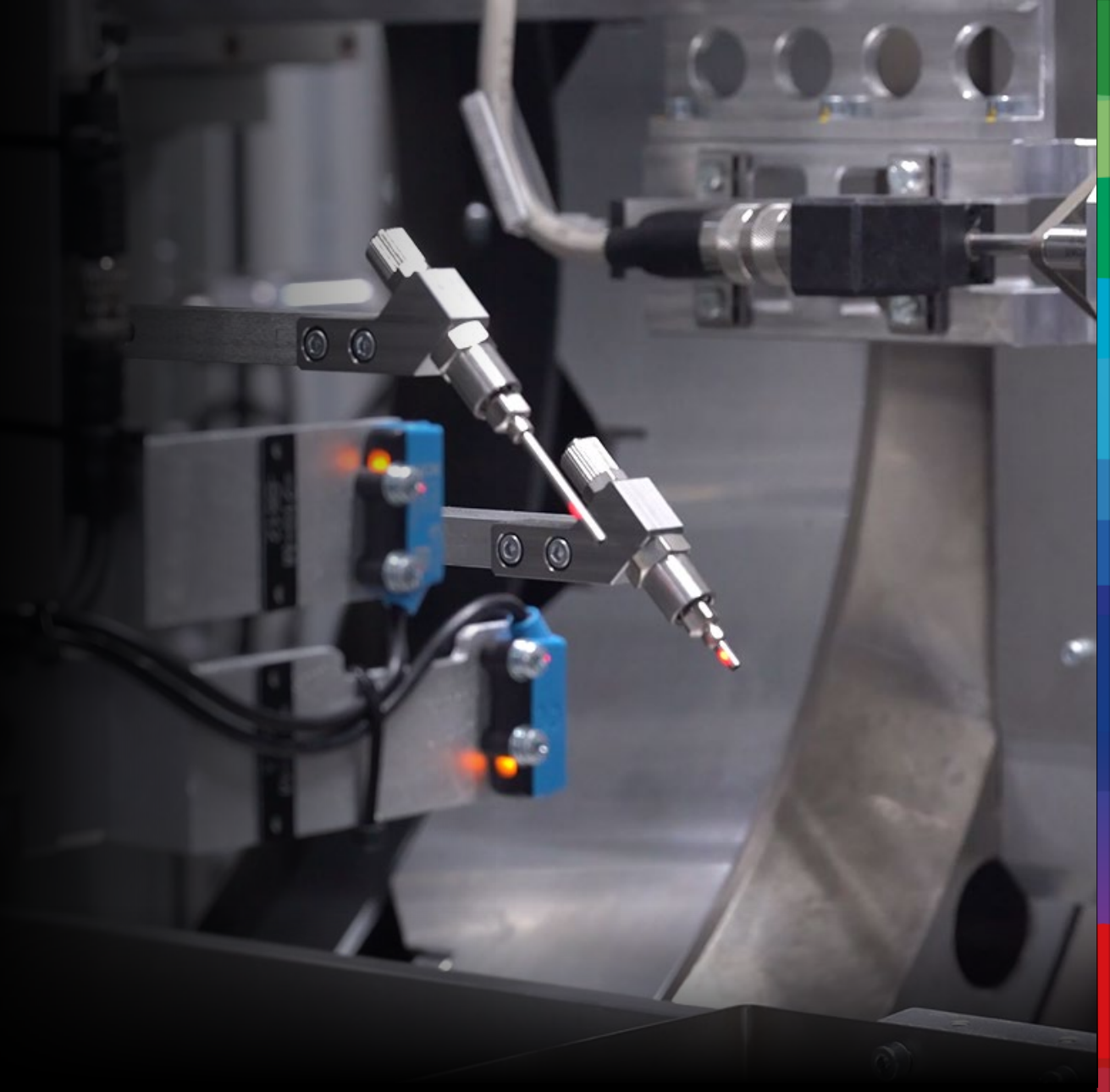
- Easy and quick automated set-up capability due to tool Change < 5 min
- Higher process stability can be achieved by separating using an NC axis (batch differences in the wires)
- Variable number of separating heads lead to a high scalability
- Adaptability to different product types: Separating heads have synchronized servo movements

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BMG | eDrive
Trickling for eDrive

- 4 nozzles, each nozzle with XZ dual-axis position servo adjustment
- Product rotation speed infinitely adjustable from 0 to 30 RPM & tilt angle infinitely adjustable from -2 to 20 degrees
- Cooperate with wiring fixtures to achieve automatic UVW three phase heating circuit connection
- Real-time data acquisition and local storage of trickling and electric heating process data
- Product actual position detection and automatic offset compensation for dripping position to ensure consistency in the dripping position of all products



Benefits

- Temperature control during trickling ensures stable stator temperature, improving resin hanging and interphase PDIV
- Using digital models and curve fitting estimates stator temperature with ±3°C accuracy, without contact
- Integrated waste disposal system collects, pre-treats gaseous volatiles, and directs them to a central pipeline
- Equipped with a carbon dioxide safety fire extinguishing system and real-time monitoring of the trickling heating area

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BMG | eDrive
Clamping

- Pairwise block clamping of wire ends in welding position in an external station to create zero gap
- Clamping force from 500N up to 1500N per slot, depending on the used system spring
- Base body for clamping same for stators with outer diameters from 120mm up to 240mm
- Tangential and vertical alignment of the wire ends

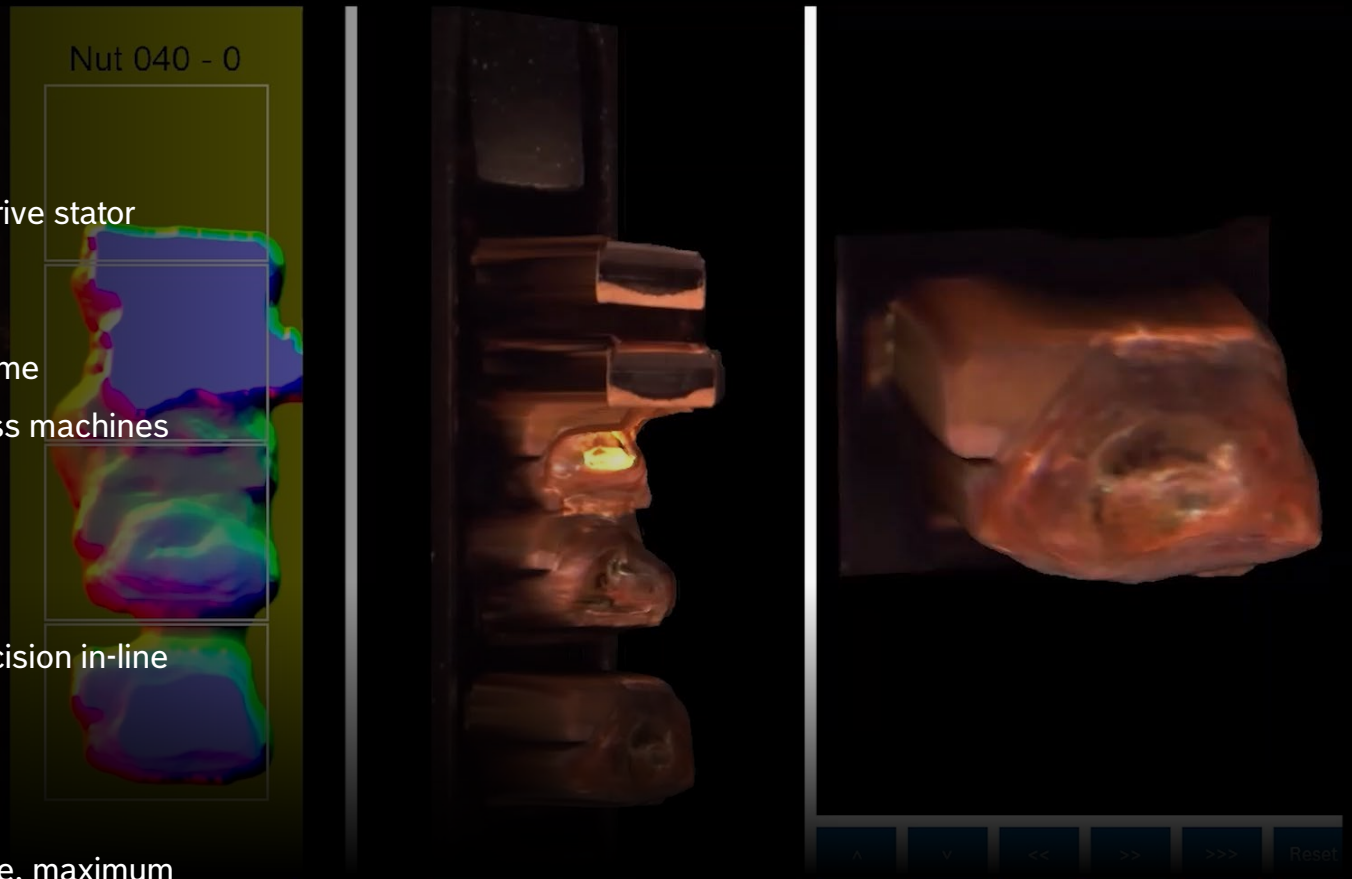
Benefits

- Blockwise clamping of the wire ends in the welding position
- Production of zero gap between the wire ends
- This allows external maintenance of the clamping tool, reducing the complexity of the laser system and increasing machine availability and uptime



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BMG | eDrive
Optical Inspection for eDrive



- High quality optical inspection machines and solutions for all kinds of eDrive stator welding and other parts
- Closed process control-loop of image processing to maintain tolerances
- Powerful software for processing of large amount of data in short cycle time
- Variety of solutions from standalone systems up to inspection and process machines
- Dedicated SW platform with comfortable user interface & AI solutions
- Highly innovative camera systems with 3D surround view in one shot
- Wide variety of high speed 2D & 3D image acquisition sensor systems
- Lateral resolutions down to few µm & height measurements with µm precision in-line
- Short cycle times of seconds

Benefits

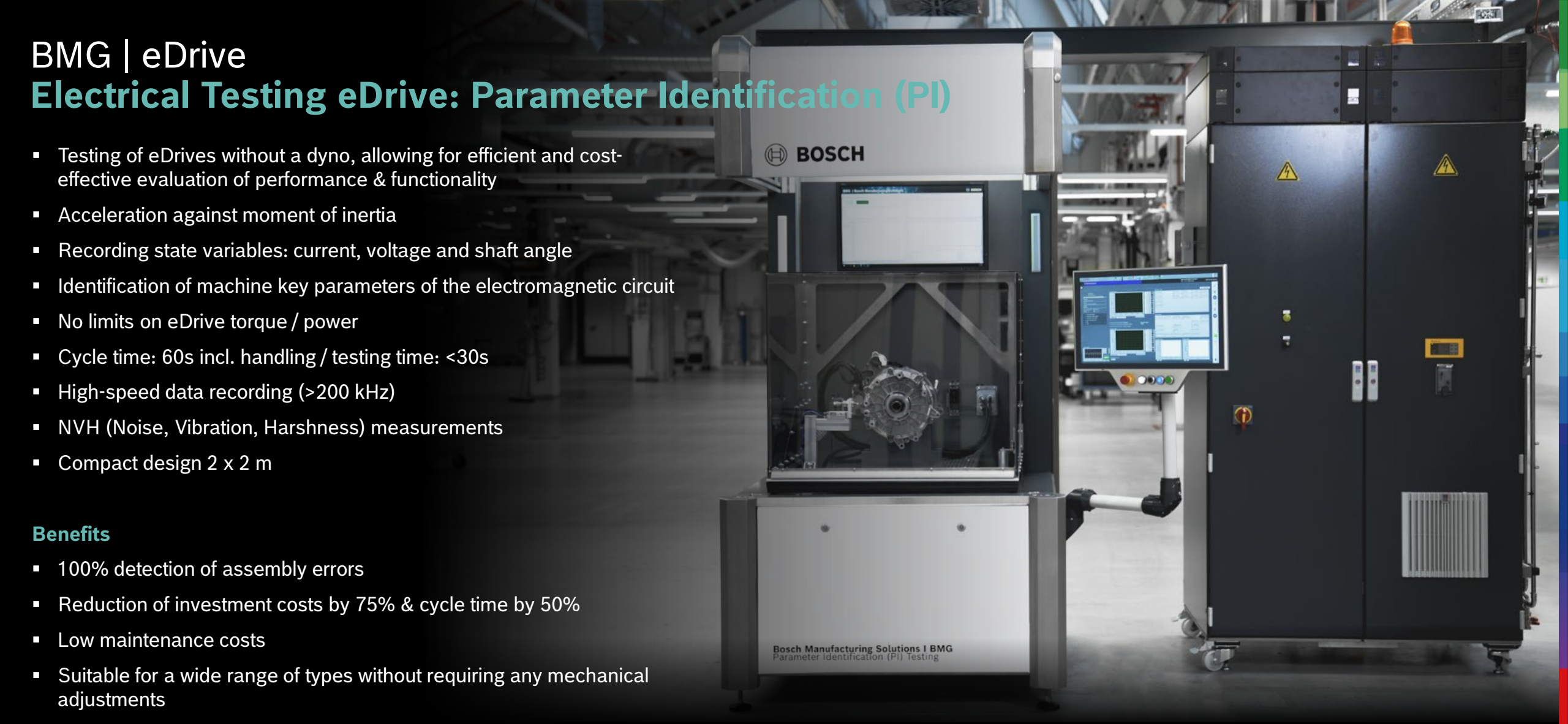
- High-speed, high-resolution sensor systems to guarantee short cycle time, maximum cost-effectiveness and best inspection quality
- Highly capable measurement systems according to quality guidelines
- Full-equipped machine vision lab for development of innovative applications
- Fast and reliable detection of OK parts or NOK → cost-effectiveness and high reliability
- Our broad technology portfolio enables us to find a suitable, cost-effective solution for every customer requirement

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BOSCH

BMG | eDrive
Electrical Testing eDrive: Parameter Identification (PI)

- Testing of eDrives without a dyno, allowing for efficient and cost-effective evaluation of performance & functionality
- Acceleration against moment of inertia
- Recording state variables: current, voltage and shaft angle
- Identification of machine key parameters of the electromagnetic circuit
- No limits on eDrive torque / power
- Cycle time: 60s incl. handling / testing time: <30s
- High-speed data recording (>200 kHz)
- NVH (Noise, Vibration, Harshness) measurements
- Compact design 2 x 2 m



Benefits

- 100% detection of assembly errors
- Reduction of investment costs by 75% & cycle time by 50%
- Low maintenance costs
- Suitable for a wide range of types without requiring any mechanical adjustments
- The test is sufficient under partial load, eliminating the need for cooling

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